#5 AF
C.C

PTO/SB/21 (09-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/082,833
Filing Date	02/25/2002
First Named Inventor	GRAVES, A. et al.
Art Unit	2874
Examiner Name	PAK, S.H.
Attorney Docket Number	P00079US2A
Total Number of Pages in This Submission	

ENCLOSURES *(Check all that apply)*

- [x] Fee Transmittal Form
  - [x] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ____________
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [x] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Return Receipt Postcard

Remarks

Fee Attached = PTO 2038
Appeal Communication to TC = Appeal Brief (in triplicate)

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Benesch Friedlander Coplan & Aronoff, LLP		
Signature			
Printed name	Gregory S. Kolocouris		
Date	August 9, 2005	Reg. No.	47,714

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature			
Typed or printed name	Bryan Jaketic	Date	August 9, 2005

O I P E JC145
AUG 1 1 2005
PATENT & TRADEMARK OFFICE

PTO/SB/17 (12-04v2)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT | ($) 500.00

Complete if Known	
Application Number	10/082,833
Filing Date	02/25/2002
First Named Inventor	GRAVES, S. et al.
Examiner Name	PAK, S. H.
Art Unit	2874
Attorney Docket No.	P00079US2A

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____________

☑ Deposit Account Deposit Account Number: 02-2051 Deposit Account Name: Benesch, Friedlander

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☐ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims ______ - 20 or HP = **Extra Claims** ______ x **Fee ($)** ______ = **Fee Paid ($)** ______

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims ______ - 3 or HP = **Extra Claims** ______ x **Fee ($)** ______ = **Fee Paid ($)** ______

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims — **Fee ($)** ______ **Fee Paid ($)** ______

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ______ - 100 = **Extra Sheets** ______ / 50 = **Number of each additional 50 or fraction thereof** ______ (round **up** to a whole number) x **Fee ($)** ______ = **Fee Paid ($)** ______

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) ______

Other (e.g., late filing surcharge): Appeal Brief 500.00

SUBMITTED BY

Signature	[signature]	Registration No. (Attorney/Agent) 47,714	Telephone (216) 363-4453
Name (Print/Type)	Gregory S. Kolocouris		Date August 9, 2005

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

OIPE JC145
AUG 1 1 2005
PATENT & TRADEMARK OFFICE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	:	GRAVES, S. et al.	Examiner	:	PAK, S. H.
Application No.	:	10/082,833	Group Art	:	2874
Filing Date	:	February 25, 2002	Docket No.	:	P00079US2A
Confirmation No.	:	4638			
Title	:	OPTICAL TRANSMISSION TUBE AND APPLICATIONS THEREOF			

Mail Stop Appeal Brief - Patents
Board of Patent Appeals and Interferences
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir/Madam:

The following Appeal Brief is submitted pursuant to the Notice of Appeal filed June 9, 2005 in the above-identified application. This Appeal Brief, filed within two months of the filing date of the Notice of Appeal with a proper certificate of mailing, is therefore timely filed. This is an appeal from the decision of the Examiner mailed February 7, 2005, finally rejecting claims 15-38, 40, 41, 43, and 44. The fees required under 37 CFR § 1.17, are detailed and properly paid as stated in the accompanying Fee Transmittal Form. This Appeal Brief is filed in triplicate pursuant to 37 CFR § 1.192(a).

08/12/2005 EFLORES 00000111 10082833
01 FC:1402 500.00 OP

TABLE OF CONTENTS

TABLE OF AUTHORITIES

Cases

Statutes

Other Authorities

I. REAL PARTY IN INTEREST

Bridgestone Americas Holding, Inc. is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

III. STATUS OF CLAIMS

Claims 15-38, 40, 41, 43, and 44, have been finally rejected under 35 U.S.C. § 103. Claims 15-38, 40, 41, 43, and 44 remain pending and are on appeal (see Section IX, Claims Appendix).

IV. STATUS OF AMENDMENTS

No amendments were filed subsequent to the final Office Action, mailed February 7, 2005 (Exhibit A, hereafter "Final Office Action").

V. SUMMARY OF CLAIMED SUBJECT MATTER

In a particular embodiment, the application relates to delineation marking systems that incorporate optical transmission tubes configured to illuminate the area in the vicinity of the optical transmission tubes.

The claimed subject matter includes a delineation marking system comprising at least one optical transmission tube assembly disposed on the delineation marker configured to outline at least a portion of the contour of a road. The optical transmission tube assembly includes an elongated body that is substantially transparent. In several claimed embodiments, the optical transmission tube assembly includes a light emitting diode ("LED"). In other claimed embodiments, the optical transmission tube assembly includes a reflective layer extending along at least a portion of the length of the elongated body.

The claimed subject matter also includes a method of guiding a vehicle driver along a road. This method includes the step of installing an optical transmission tube assembly along a portion of the road.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 15-38, 40, 41, 43, and 44 have been rejected under 35 U.S.C. § 103(a) as being obvious in light of U.S. Patent No. 6,592,245 to Tribelsky et al. (Exhibit B, hereafter "Tribelsky '245") in view of U.S. Patent No. 5,982,969 to Sugiyama et al. (Exhibit C, hereafter "Sugiyama '969"). The Office acknowledges that Tribelsky '245 does not teach or suggest a reflective layer in strip form extending along the transmission tube or an LED. The Office relies on Sugiyama '969 to supply the missing limitations.

VII. ARGUMENT

Claims 15-38, 40, 41, 43, and 44 are not obvious in light of Tribelsky '245 in view of Sugiyama '969 under 35 U.S.C. § 103.

A. Brief Discussion of References

Tribelsky '245 describes a fiber optic system and method for illuminating an elongated indication path (abstract). To illuminate the elongated indication path, Tribelsky '245 employs a side emitting optical fiber (col. 1, lines 12-20) and a high intensity light source (col. 5, lines 40-43). The side emitting optical fibers of Tribelsky '245 transmit light from one end to the other via total internal reflection (col. 4, lines 64-67), while simultaneously allowing some portion of the transmitted light to escape along the length of the fiber (col. 5, lines 59-67). The side emitting optical fibers are provided within a flexible, semi-opaque sleeve that is holographically grooved to allow light of a predetermined wavelength to escape at a predetermined angle and to provide uniform visible transmission of light along the path (col. 3, lines 15-21).

In one embodiment, Tribelsky '245 teaches that side emitting optical fibers may be embedded in a road surface or employed along a road side barrier to illuminate a driver's path (col. 7, lines 56-61). This embodiment, exemplified in Figure 6, is the only embodiment relevant to the present application.

Tribelsky '245 concedes that the use of side emitting optical fibers for illumination was well-known in the art, but states that earlier devices were limited to short distance illuminations (col. 2, lines 8-14). Tribelsky '245 cites U.S. Patent No. 4,422,719 (issued December 27, 1983)

as an early example of a short distance illumination device. Tribelsky '245 distinguished itself from the prior art by specifically designing a device to illuminate long paths (col. 3, lines 37-38). For example, Tribelsky '245 teaches that a single device can be used to illuminate a road barrier of more than two kilometers in length (col. 7, lines 61-64).

Sugiyama '969 describes an optical transmission tube having a transparent core for illuminating a short path (col. 4, lines 25-30). The optical transmission tube further includes a reflective strip along a portion of the length of the tube (col. 4, lines 30-31). The end of the tube is coupled to an LED, which supplies light to the optical transmission tube (col. 7, lines 36-44). Sugiyama '969 fails to teach an optical transmission tube assembly disposed on a delineation marker configured to outline at least a portion of the contour of a road.

B. <u>Law and Argument</u>

In order to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. MPEP § 2143.

Further, the proposed modification cannot render the prior art unsatisfactory for its intended purpose. MPEP § 2143.01. If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984).

Moreover, the fact that references can be combined or modified is not sufficient to establish *prima facie* obviousness. MPEP § 2143.01. The mere fact that references *can* be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680 (Fed. Cir. 1990).

In the Final Office Action, the Office expressly concedes that Tribelsky '245 does "not explicitly teach the use of a reflective layer in a strip form extending along the transmission tube... and a light source being a light emitting diode" (Exhibit A, Final Office Action, pages 2-

3). The Office relies on Sugiyama '969 to supply these missing limitations. However, as discussed in more detail below, Appellant submits that Tribelsky '245 teaches away from such limitations, thus there is no motivation to combine the limitations of Sugiyama '969 with the light guide of Tribelsky '245. In fact, the LED of Sugiyama '969 would render the light guide of Tribelsky '245 unfit for its intended purpose.

Additionally, in the Final Office Action, the Office states that Tribelsky '245 inherently teaches that the optical fiber is an elongated body that is substantially transparent. As discussed in more detail below, Appellant submits that Tribelsky '245 contains no such teaching and, in fact, teaches away from a substantially transparent optical fiber.

1. <u>Tribelsky '245 teaches away from the use of an LED as a light source</u>

In the present application, claim 27 calls for an LED provided at an end portion of an elongated body of an optical transmission tube assembly. Claims 28-33 depend from claim 27 and incorporate this limitation.

Claim 34 also calls for an LED provided at an end portion of an elongated body of an optical transmission tube assembly. Claims 35-38, 40, and 44 depend from claim 34 and incorporate this limitation.

Claim 41 calls for an LED provided at an end portion of the optical transmission tube.

The Office rejected claims 27-38, 40, 41, 43, and 44 under 35 U.S.C. § 103 as unpatentable over Tribelsky '245 in view of Sugiyama '969. The Office concedes that Tribelsky '245 does not disclose, teach, or otherwise suggest the use of an LED. The Office relies on Sugiyama '969 to supply this missing limitation. However, Tribelsky '245 teaches away from the use of an LED and, thus, there is no motivation to combine the two references.

Tribelsky '245 discloses a long light guide that requires a high intensity light source (col. 5, lines 40-43). Examples of light sources disclosed include Halogen lamps, Metal Halide lamps, Micro-wave excitation lamps, Micro-wave excitation fiber lamps, Lasers, and flash type lamps, all of which are high intensity light sources (col. 13, lines 2-10).

While Tribelsky '245 does teach a light guide disposed along a road, the disclosure is directed to long light guides (col. 3, lines 37-38). For example, Tribelsky '245 teaches that a single light source and optical fiber assembly can be used to illuminate a barrier of more than

two kilometers in length (col. 7, lines 61-64). Tribelsky '245 expressly teaches away from the use of light guides having a short length. In the Background of the Invention, Tribelsky '245 states:

> the optical marking of an elongated indication path is prohibitively expensive and cumbersome because a large number of light sources are required, these well known methods include serial connection of a plurality of light sources (e.g. each light source is aligned to single light guide, fiber, or light conduits or lens or signs and signals) without the ability to efficiently combine their collective outputs for long distance high intensity optical marking or illumination. Thus use of elongated illumination paths have found only limited uses in critical applications (such as highlighting air transport runways, oceanographic optical marking or illumination systems or ITS type systems (e.g. Intelligent Transport Systems—optical traffic warning signals) lighting systems and/or efficient light distribution fiber networks for optical marking or illumination) (col. 1, lines 41-55).

In sum, the short light guides of the prior art were ill-suited for marking paths along roads because they were expensive, cumbersome, and difficult to maintain. Tribelsky '245 overcame the problems inherent to short light guides by using an elongated light guide (up to two kilometers in length) and a high intensity light source. To employ a single light guide along two kilometers of a highway, a high intensity light source is required to maintain uniform illumination. Indeed, Tribelsky '245 discloses the use of a 1000 Watt lamp as a light source (col. 15, lines 18-23) in connection with the Figure 6 embodiment. Therefore, Tribelsky '245 teaches away from a low-intensity light source, such as an LED, and thus there is no motivation to so modify the reference.

Moreover, the LED of Sugiyama '969 would render the light guide of Tribelsky '245 unsuitable for its intended purpose. A proposed modification cannot render the prior art unsatisfactory for its intended purpose. MPEP § 2143.01. If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984).

The LED of Sugiyama '969 is a low-intensity light source that is unsuitable for illuminating the elongated path of Tribelsky '245. At the time of invention, LEDs fell within the range of 0.04 Watts to 5 Watts (*see* Exhibit D, Light Emitting Diodes, www.wikipedia.com, p.

7). If the LED of Sugiyama '969 were combined with the optical fiber light guide of Tribelsky '245, it would result in an elongated light guide that provides very poor illumination. Accordingly, the Office's proposed modification would render Tribelsky '245 unsatisfactory for its intended purpose. *See* MPEP § 2443.01. Therefore, there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984).

For these reasons, Appellant respectfully submits that the rejection of claims 27-38, 40, 41, 43, and 44 under 35 U.S.C. § 103 is improper and the claims are not rendered obvious by Tribelsky '245 in view of Sugiyama '969.

2. <u>Tribelsky '245 teaches away from the use of a reflective strip</u>

In the present application, claim 15 calls for a reflective layer extending along at least a portion of the length of the elongated body of the optical transmission tube assembly. Claims 16-26 and 43 depend from claim 15 and incorporate this limitation.

Claim 34 also calls for a reflective layer extending along at least a portion of the length of the elongated body of the optical transmission tube assembly. Claims 35-38, 40, and 44 depend from claim 34 and incorporate this limitation.

Claim 41 calls for a reflecting layer in strip form extending along at least a portion of the length of the tubular body.

The present application employs a reflective layer to reflect light through the optical transmission tube such that it emerges from the opposite side of the reflective layer (p. 7, lines 16-26). The Office rejected claims 5-26, 34-38, 40, 41, 43 and 44 under 35 U.S.C. § 103 over Tribelsky '245 in view of Sugiyama '969. The Office concedes that Tribelsky '245 does not disclose, teach, or otherwise suggest the use of a reflective strip. The Office relies on Sugiyama '969 to supply this missing limitation. However, the reflective strip of Sugiyama '969 would serve no function if applied to the light guide of Tribelsky '245. Thus, there is no motivation to combine the two references.

Tribelsky '245 employs a light guide including side emitting optical fibers that transmit light via total internal reflection (col. 4, lines 64-67). Such side emitting optical fibers transmit light from one end to another, while allowing some portion of transmitted light to escape along the length of the fiber (col. 5, lines 59-67). Conversely, any light that is input along the sides of

the fibers (such as light reflected off a reflective strip) would not pass through the opposite side of the fiber, but would instead be transmitted via total internal reflection along the length of the fiber (*see* Exhibit E, "A Fluorescent Long-Line Fiber-Optic Position Sensor," www.sensormag.com, p. 3). Tribelsky '245 acknowledges the limitations of side emitting fibers with respect to directional control of light in that Tribelsky '245 only employs reflectors that reflect light *away* from the optical fibers and towards another desired location (see col. 18, lines 27-30; col. 18, lines 44-51; and col. 19, lines 58-67).

Sugiyama '969 employs a reflective layer to reflect light through an optical transmission tube, such that it emerges from an area opposite the reflective layer (col. 4, lines 39-44). If the reflective layer of Sugiyama '969 were combined with the light guide of Tribelsky '245, light reflected from the reflective layer would be transmitted along the length of the fiber rather than towards the desired location. Thus, the reflective layer would not perform the function of illuminating a desired area.

The fact that references *can* be combined or modified is not sufficient to establish *prima facie* obviousness. MPEP § 2143.01. Instead, the prior art must suggest the desirability of the combination. *Id.* Employing the reflective layer of Sugiyama '969 along the optical fibers of Tribelsky '245 would serve no function. Thus, Sugiyama '969 provides no motivation to so modify Tribelsky '245, and the teachings of Sugiyama '969 and Tribelsky '245 are insufficient to establish *prima facie* obviousness. *See In re Mills*, 916 F.2d 680.

Furthermore, Tribelsky '245 employs a bundle of optical fibers enclosed within a semi-opaque sleeve (col. 8, lines 14-34). The Office has interpreted each optical fiber as "an elongated body that is substantially transparent" (Exhibit A, p. 3). If the reflective layer of Sugiyama '969 were provided on each side emitting optical fiber of Tribelsky '245, it would result in a plurality of reflective layers disposed throughout a bundle of optical fibers. The plurality of reflective layers would scatter light in different directions, rather than in a single direction. Accordingly, the Office's proposed modification would render Tribelsky '245 unsatisfactory for its intended purpose. *See* MPEP § 2143.01. Therefore, there is no suggestion or motivation to make the proposed modification. *See In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984)

For these reasons, Appellant respectfully submits that the rejection of claims 15-26, 34-38, 40, 41, 43 and 44 under 35 U.S.C. § 103 is improper and the claims are not rendered obvious by Tribelsky '245 in view of Sugiyama '969.

3. <u>Tribelsky '245 teaches away from a substantially transparent transmission tube</u>

In the present application, claims 15, 27, 34, and 41 all call for an optical transmission tube assembly that includes an elongated body that is substantially transparent. Claims 16-26 and 43 depend from claim 15 and incorporate this limitation. Claims 28-33 depend from claim 27 and incorporate the above limitation. Claims 35-38, 40, and 44 depend from claim 34 and incorporate the above limitation.

Tribelsky '245 does not teach an optical transmission tube assembly having an elongated body that is substantially transparent. The Office concedes that Tribelsky '245 does not explicitly teach a substantially transparent body, but rather states that the side emitting optical fibers of Tribelsky '245 are inherently transparent. Appellant respectfully disagrees. In fact, the side emitting optical fibers or Tribelsky '245 are *not* substantially transparent. As explained above, light that impinges on the side of the fibers does not pass directly through the fibers. Instead, it is either reflected off the fiber or transmitted via total internal reflection along the length of the fiber towards either end (*see* Exhibit E, "A Fluorescent Long-Line Fiber-Optic Position Sensor," www.sensormag.com, p. 3).

For this reason, Appellant respectfully submits that the rejection of claims 15-38, 40, 41, 43 and 44 under 35 U.S.C. § 103 is improper and the claims are not rendered obvious by Tribelsky '245 in view of Sugiyama '969.

VIII. CONCLUSION

Appellant submits that the pending claims are allowable and urges allowance of the claims at an early date.

The Commissioner is hereby authorized to charge any additional fees, or credit any overpayment to Deposit Account No. 02-2051, referencing Attorney Docket No. P00079US2A.

Respectfully submitted,

Dated: August 9, 2005

By: ______________________

Gregory S. Kolocouris
Registration No. 47,714

**BENESCH, FRIEDLANDER,
COPLAN & ARONOFF, LLP**
2300 BP Tower
200 Public Square
Cleveland, OH 44114
Direct Dial: (216) 363-4453

IX. CLAIMS APPENDIX

IN THE CLAIMS:

Claims 1-14 (cancelled)

15. (previously presented) A delineation marking arrangement for use along a road, the delineation marking arrangement comprising:

a delineation marker configured to outline at least a portion of the contour of the road; and

at least one optical transmission tube assembly disposed on the delineation marker, the optical transmission tube assembly being configured to be visibly detected by a vehicle driver to convey road-related information to the vehicle driver.

wherein the optical transmission tube assembly includes:

an elongated body that is substantially transparent,

a reflective layer extending along at least a portion of the length of the elongated body, and

a light source provided at an end portion of the elongated body.

16. (previously presented) The delineation marking arrangement of claim 15, wherein the delineation marker includes a guard rail that extends along at least a portion of the road.

17. (previously presented) The delineation marking arrangement of claim 16, wherein the guard rail extends along a curved portion of the road.

18. (previously presented) The delineation marking arrangement of claim 15, wherein the delineation marker includes at least one barrier wall that extends along at least a portion of the road.

19. (previously presented) The delineation marking arrangement of claim 15, wherein the delineation marker includes a plurality of barrier walls that extend along at least a portion of the road.

20. (previously presented) The delineation marking arrangement of claim 15, wherein the optical transmission tube assembly is configured to transmit light along at least a portion of the length of the elongated body when light is emitted from the light source.

21. (previously presented) The delineation marking arrangement of claim 20, wherein the light source includes a light emitting diode.

22. (previously presented) The delineation marking arrangement of claim 15, wherein the optical transmission tube assembly is connected to a top edge of the delineation marker.

23. (previously presented) The delineation marking arrangement of claim 15, wherein the road-related information conveyed to the vehicle driver includes the existence of an impending curve, jog, or other change in road direction.

24. (previously presented) The delineation marking arrangement of claim 15, wherein the road-related information conveyed to the vehicle driver includes the existence of an end of the road or an edge of the road.

25. (previously presented) The delineation marking arrangement of claim 15, wherein the road-related information conveyed to the vehicle driver includes the existence of a road hazard or other road obstacle to thereby guide the vehicle driver around such road hazard or other road obstacle.

26. (previously presented) The delineation marking arrangement of claim 15, wherein the optical transmission tube assembly is illuminated to be visibly detected.

27. (previously presented) A method of guiding a vehicle driver along a road having a contour, the method comprising the steps of:

installing a delineation marker along at least a portion of the road to outline the contour of the road, the delineation marker having an optical transmission tube provided thereon;

wherein the optical transmission tube assembly includes:

an elongated body that is substantially transparent, and

a light emitting diode provided at an end portion of the elongated body; and

illuminating the optical transmission tube to guide the vehicle driver along the road.

28. (previously presented) The method of claim 27, wherein the delineation marker installation step includes the step of installing the optical transmission tube onto a top lip of the delineation marker.

29. (previously presented) The method of claim 27, wherein the delineation marker installation step includes the step of installing the optical transmission tube above the delineation marker.

30. (previously presented) The method of claim 27, wherein the delineation marker includes a plurality of optical transmission tubes provided thereon.

31. (previously presented) The method of claim 27, wherein the delineation marker includes a guard rail.

32. (previously presented) The method of claim 27, wherein the delineation marker includes a plurality of barrier walls.

33. (previously presented) The method of claim 27, wherein the optical transmission tube illumination step enhances vehicle driver preview distance.

34. (previously presented) A delineation marking system for use along a travel path having a contour, the delineation marking system comprising:

a structure configured to outline at least a portion of the contour of the road;

an optical transmission tube assembly supported by the structure, the optical transmission tube assembly being configured to be used as an illuminated indicator

wherein the optical transmission tube assembly includes:

an elongated body that is substantially transparent;

a reflective layer extending along at least a portion of the length of the elongated body; and

a light emitting diode provided at an end portion of the elongated body,

wherein the optical transmission tube assembly is configured to transmit light along at least a portion of the length of the elongated body when light is emitted from the light emitting diode.

35. (previously presented) The delineation marking system of claim 34, wherein the structure includes a guard rail that extends along at least a portion of the travel path.

36. (previously presented) The delineation marking system of claim 34, wherein the structure includes a plurality of barrier walls that extend along at least a portion of the travel path.

37. (previously presented) The delineation marking system of claim 34, wherein the illuminated indicator indicates the existence of an impending curve, jog or other change in road direction.

38. (previously presented) The delineation marking system of claim 34, wherein the illuminated indicator indicates the existence of a road hazard or other road obstacle.

39. (cancelled)

40. (previously presented) The delineation marking system of claim 34, wherein light is emitted radially outward from the optical transmission tube.

41. (previously presented) A delineation marker system for use along a travel path, the delineation marker system comprising:

a plurality of barrier walls; and

one or more optical transmission tubes provided on one or more of the barrier walls, the optical transmission tubes configured to be illuminated to outline the travel path, wherein each optical transmission tube includes:

a substantially transparent tubular body; and

a reflecting layer in strip form extending along at least a portion of the length of the tubular body; and

a light emitting diode provided at an end portion of the optical transmission tube, the light emitting diode configured to supply light to the optical transmission tube such that light is reflected and scattered by the reflecting layer to cause such light to emerge from the optical transmission tube.

42. (cancelled)

43. (previously presented) The delineation marking arrangement of claim 15, wherein the elongated body is constructed of acrylic.

44. (previously presented) The delineation marking system of claim 34, wherein the elongated body is constructed of acrylic.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/082,833	02/25/2002	Stephen M. Graves	P00079US2A	4638

7590 08/11/2004

Chief Intellectual Property Counsel
Bridgestone Americas Holding, Inc.
1200 Firestone Parkway
Akron, OH 44317

EXAMINER	
PAK, SUNG H	
ART UNIT	**PAPER NUMBER**
2874	

DATE MAILED: 08/11/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	**Application No.** 10/082,833	**Applicant(s)** GRAVES ET AL.
	Examiner Sung H. Pak	**Art Unit** 2874

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _21 May 2004_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _15-42_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _15-42_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _25 February 2002_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _0602_.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Applicant's amendment filed 5/21/2004 has been entered. Claims 15-42 are now pending. In response to the amendment, the claims have been examined on merit and prior art rejections are made in this office action.

Information Disclosure Statement

Information disclosure statement filed 6/03/2002 has been considered. Please refer to the initialed copy of the information disclosure statement.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

Claims 15, 20, 21, 25, 26, 34, 39, 40 are rejected under 35 U.S.C. 102(b) as being anticipated by Sugiyama et al (US 5,982,969).

FIG.10

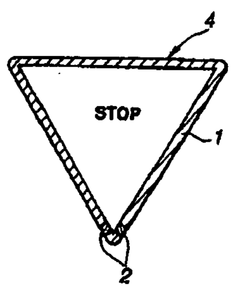


FIG.18

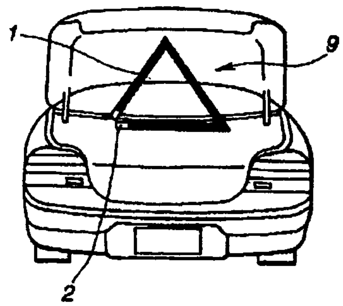
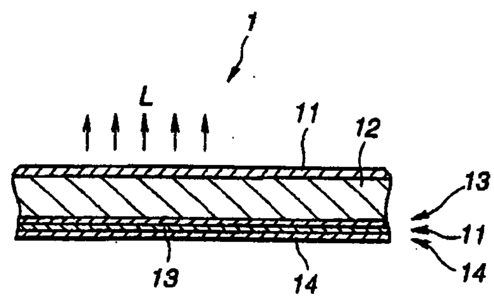


FIG.1

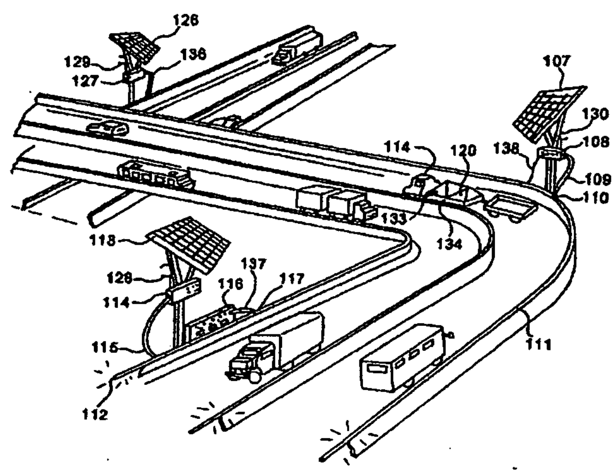


Sugiyama et al was cited in the information disclosure statement.

Sugiyama discloses an optical device with all the limitations set forth in the claims, including: a delineation marker of a stop/ hazard sign (Fig. 10, Fig. 18- delineating the outer edge of stop/hazard sign); at least one optical transmission tube assembly disposed on the marker of stop/hazard sign (column 13 lines 22-25); the optical transmission tube assembly visibly detected by a vehicle driver to convey road-related information to the driver (Fig. 10, Fig. 18); wherein the optical transmission tube assembly includes an elongated body that is substantially transparent (Fig. 1, column 4 lines 25-29); a reflective layer extending along at least a portion of the length of the elongated body ('13' Fig. 1, column 4 lines 30-31); a light source provided at an end portion of the elongated body (Fig. 4-5); wherein the optical transmission tube assembly is configured to transmit light along at least a portion of the length of the elongated body when light is emitted from the light source (Fig. 1); wherein the light source includes a light emitting diode (column 7 line 62); wherein the light is emitted radially outward (Fig. 2); wherein the road-related information conveyed to the vehicle driver includes the

existence of a road hazard or road obstacle (Fig. 10, Fig. 18); wherein the optical transmission tube assembly is illuminated to be visibly detected (Fig. 1).

Claim 15-19, 22-24, 27-38, 41 are rejected under 35 U.S.C. 102(e) as being anticipated by Tribelsky et al (US 6,592,245 B1).



Tribelsky discloses an optical system with all the limitations set forth in the claim, including: a delineation marker (delineating the edges of the road- see figure above); wherein the delineation marker includes a guard rail for the road (figure above); wherein the guard rail extends along a curved portion of the road (figure above); wherein the delineation maker includes plurality of guard rails that are plurality of barrier walls (on either side of the road- see figure above); one or more optical transmission tubes provided on one or more of the barrier walls, the transmission tubes configured to illuminate and outline the travel path (Figure above; abstract); wherein the optical transmission tube assembly is connected to the top edge of the delineation marker (figure above); wherein the delineation marker convey impending curve or edge of the road (figure above); wherein the illumination enhances vehicle driver preview distance (inherently disclosed by the teaching of the reference).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tribelsky et al (US 6,592,245 B1) in view of Sugiyama et al (US 5,982,969).

Tribelsky discloses an optical system with all the limitations set forth in the claims as discussed above, except it does not teach the use of a reflecting layer in a strip form extending along at least a portion of the length of the optical transmission tube.

Sugiyama explicitly teaches the use of a reflective layer strip in extending along at least a portion of the length of the optical transmission tube (Fig. 1-2; see discussion above). The use of a reflective layer on optical transmission tube is advantageous and desirable, because it efficiently directs the transmitted light in the illumination direction. Thus, the reflective layer increases the illumination efficiency of the device.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the Tribelsky device to have a reflective layer strip extending along at least a portion of the length of the optical transmission tube.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Sung H. Pak whose telephone number is (571) 272-2353. The examiner can normally be reached on Monday- Friday, 9AM-5PM.

The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Sung H. Pak
Examiner
Art Unit 2874

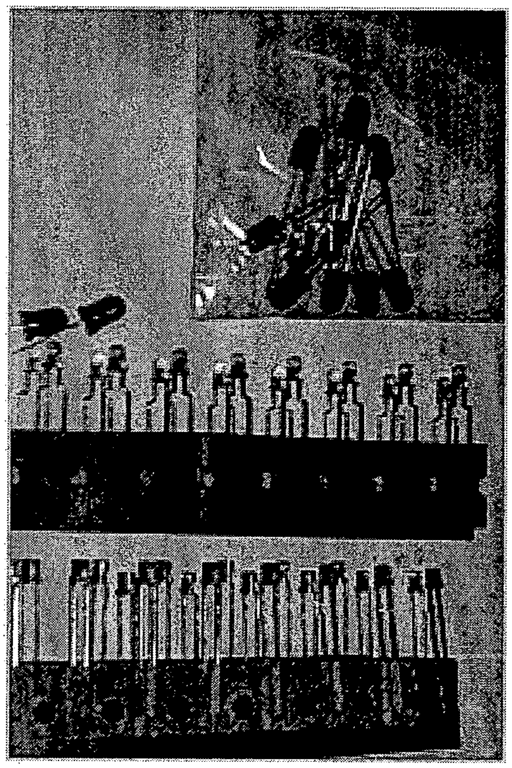
sp

Light-emitting diode

From Wikipedia, the free encyclopedia.

(Redirected from LED)

LED redirects here. For other uses, see LED (disambiguation).



Various light-emitting diodes (5 mm reds, 3 mm greens and yellows)

A **light-emitting diode (LED)** is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction. This effect is a form of electroluminescence. The color of the emitted light depends on the chemical composition of the semiconducting material used, and can be near-ultraviolet, visible or infrared. Nick Holonyak Jr. (born 1928) of the University of Illinois at Urbana-Champaign developed the first practical visible-spectrum LED in 1962.[1]

Contents

LED technology

Physical function

An LED is a special type of semiconductor diode. Like a normal diode, it consists of a chip of semiconducting material impregnated, or *doped*, with impurities to create a structure called a *p-n junction*. Charge-carriers - electrons and holes flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon as it does so.

Light emission

The wavelength of the light emitted, and therefore its color, depends on the bandgap energy of the materials forming the pn junction. A normal diode, typically made of silicon or germanium, emits invisible far-infrared light, but the materials used for an LED have bandgap energies corresponding to near-infrared, visible or near-ultraviolet light.

Considerations in use

Unlike incandescent light bulbs, which can operate with either AC or DC, LEDs require a DC supply of the correct electrical polarity. When the voltage across the pn junction is in the correct direction, a significant current flows and the device is said to be *forward-biased.* If the voltage is of the wrong polarity, the device is said to be *reverse biased*, very little current flows, and no light is emitted. Most LEDs have low *reverse breakdown voltage* ratings and will be damaged by an applied reverse voltage of more than a few volts.

Because the voltage versus current characteristics of an LED are much like any diode, they can be destroyed by connecting them to a voltage source higher than their turn-on voltage. A good LED driver circuit is either a constant current source or an approximation to a current source made by connecting the LED in series with a current limiting resistor to a voltage source. The voltage drop across a forward-biased LED can change significantly based on current flow.

Parallel operation is generally problematic. The LEDs have to be of the same type in order to have a similar forward voltage. Even then, variations in the manufacturing process can make the odds of satisfactory operation low. For more information see Nichia Application Note.

Some LED units contain two diodes, one in each direction (that is, two diodes in *inverse parallel*) and each a different color (typically red and green), allowing two-color operation or a range of apparent colors to be created by altering the percentage of time the voltage is in each polarity. Other LED units contain two or more diodes (of different colors) arranged in either a *common anode* or *common cathode* configuration. These can be driven to different colors without reversing the polarity.

Determining polarity

Close-up of a typical LED, showing the internal structure.

The correct polarity of an LED can *usually* be determined as follows:

sign:	+	–
polarity:	positive	negative
terminal:	anode	cathode
wiring:	red	black
pinout:	long	short
interior:	small	large
shape:	round	flat
marking:	none	stripe

Note that some manufacturers may not follow these standards, so if possible it should be looked-up first, or tested in series with a resistor.

LED materials

LED development began with infrared and red devices made with gallium arsenide. Advances in

materials science have made possible the production of devices with ever shorter wavelengths, producing light in a variety of colors.

Conventional LEDs are made from a variety of inorganic minerals, producing the following colors:

- aluminium gallium arsenide (AlGaAs) - red and infrared
- gallium aluminium phosphide - green
- gallium arsenide/phosphide (GaAsP) - red, orange-red, orange, and yellow
- gallium nitride (GaN) - green, pure green (or emerald green), and blue
- gallium phosphide (GaP) - red, yellow and green
- zinc selenide (ZnSe) - blue
- indium gallium nitride (InGaN) - bluish-green and blue
- indium gallium aluminium phosphide - orange-red, orange, yellow, and green
- silicon carbide (SiC) as substrate - blue
- diamond (C) - ultraviolet
- silicon (Si) as substrate - blue (under development)
- sapphire (Al_2O_3) as substrate - blue

Blue and white LEDs

Commercially viable blue LEDs based on the wide bandgap semiconductor gallium nitride were invented by Shuji Nakamura while working in Japan at Nichia Corporation in 1993 and became widely available in the late 1990s. They can be added to existing red and green LEDs to produce white light.

Most "white" LEDs in production today use a 450 nm – 470 nm blue GaN (gallium nitride) LED covered by a yellowish phosphor coating usually made of cerium-doped yttrium aluminium garnet (YAG:Ce) crystals which have been powdered and bound in a type of viscous adhesive. The LED chip emits blue light, part of which is converted to yellow by the YAG:Ce. The single crystal form of Ce:YAG is actually considered a scintillator rather than a phosphor. Since yellow light stimulates the red and green receptors of the eye, the resulting mix of blue and yellow light gives the appearance of white.

White LEDs can also be made by coating near ultraviolet (NUV) emitting LEDs with a mixture of

high efficiency europium based red and blue emitting phosphors plus green emitting copper and aluminium doped zinc sulfide (ZnS:Cu,Al). This is a method analogous to the way fluorescent lamps work.

The newest method used to produce white light LEDs uses no phosphors at all and is based on homoepitaxially grown zinc selenide (ZnSe) on a ZnSe substrate which simultaneously emits blue light from its active region and yellow light from the substrate.

Other colors

Recent color developments include pink and purple. They consist of one or two phosphor layers over a blue LED chip. The first phosphor layer of a pink LED is a yellow glowing one, and the second phosphor layer is either red or orange glowing. Purple LEDs are blue LEDs with an orange glowing phosphor over the chip. Some pink LEDs have run into issues. For example, some are blue LEDs painted with fluorescent paint or fingernail polish that can wear off, and some are white LEDs with a pink phosphor or dye that unfortunately fades after a short time.

Ultraviolet, blue, pure green, white, pink and purple LEDs are relatively expensive compared to the more common reds, oranges, greens, yellows and infrareds and are thus less commonly used in commercial applications.

The semiconducting chip is encased in a solid plastic lens, which is much tougher than the glass envelope of a traditional light bulb or tube. The plastic may be colored, but this is only for cosmetic reasons or to improve the contrast ratio; the color of the packaging does not substantially affect the color of the light emitted.

Organic light-emitting diodes (OLEDs)

If the emissive layer material of an LED is an organic compound, it is known as an Organic Light Emitting Diode (OLED). To function as a semiconductor, the organic emissive material must have conjugated pi bonds. The emissive material can be a small organic molecule in a crystalline phase, or a polymer. Polymer materials can be flexible; such LEDs are known as PLEDs or FLEDs.

Compared with regular LEDs, OLEDs are lighter and polymer LEDs can have the added benefit of being flexible. Some possible future applications of OLEDs could be:

- Inexpensive, flexible displays
- Light sources
- Wall decorations
- Luminous cloth

Operational parameters and efficiency

Most typical LEDs are designed to operate with no more than 30-60 milliwatts of electrical power. Around 1999, commercial LEDs capable of continuous use at one watt of input power were introduced. These LEDs used much larger semiconductor die sizes to handle the large power input. As well, the semiconductor dies were mounted to metal slugs to allow for heat removal from the LED die. In 2002, 5-watt LEDs were available with efficiencies of 18-22 lumens per watt. It is projected that by 2005, 10-watt units will be available with efficiencies of 60 lumens per watt. These devices will produce about as much light as a common 50-watt incandescent bulb, and will facilitate use of LEDs for general illumination needs.

In September 2003 a new type of blue LED was demonstrated by the company Cree, Inc. to have 35% efficiency at 20 mA. This produced a commercially packaged white light having 65 lumens per watt at 20 mA, becoming the brightest white LED commercially available at the time.

Today, OLEDs operate at substantially lower efficiency than inorganic (crystaline) LEDs. The best efficiency of an OLED so far is about 10%. These promise to be much cheaper to fabricate than inorganic LEDs, and large arrays of them can be deposited on a screen using simple printing methods to create a color graphic display so there are compensating benefits.

Advantages of using LEDs

- LEDs are capable of emitting light of an intended color without the use of color filters that traditional lighting methods require.
- The shape of the LED package allows light to be focused. Incandescent and fluorescent

sources often require an external reflector to collect light and direct it in a useable manner.
- LEDs are built inside solid cases that protect them, making them hard to break and extremely durable.
- LEDs have an extremely long life span: twice as long as the best fluorescent bulbs and twenty times longer than the best incandescent bulbs.

LED applications

Here is a list of known applications for LEDs, some of which are further elaborated upon in the following text:

- in general, commonly used as information indicators in various types of embedded systems (many of which are listed below)
- thin, lightweight message displays, e.g. in public information signs (at airports and railway stations, among other places)
- red LEDs have been used to replace incandescant bulbs in Railroad Crossing lights.
- status indicators, e.g. on/off lights on professional instruments and consumers audio/video equipment
- infrared LEDs in remote controls (for TVs, VCRs, etc)
- clusters in traffic signals, replacing ordinary bulbs behind colored glass
- car indicator lights and bicycle lighting; also for pedestrians to be seen by car traffic
- calculator and measurement instrument displays (seven segment displays), although now mostly replaced by LCDs
- red or yellow LEDs are used in indicator and [alpha]numeric displays in environments where night vision must be retained: aircraft cockpits, submarine and ship bridges, astronomy observatories, and in the field, e.g. night time animal watching and military field use
- red or yellow LEDs are also used in photographic darkrooms, for providing lighting which does not lead to unwanted exposure of the film
- illumination, for example, flashlights (US) / torches (UK), and backlights for LCD screens
- signaling/emergency beacons and strobes
- movement sensors, for example, in mechanical and optical computer mice and trackballs
- in LED printers such as high-end color printers
- phototherapy, the concept of using light for healing purposes
- General household illumination
- As a light source in fiber optic communications

LEDs offer benefits in terms of maintenance and safety. The typical working lifetime of a device, including the bulb, is ten years, which is much longer than the lifetimes of most other light

sources. Further, LEDs fail by dimming over time, rather than the abrupt burn-out of incandescent bulbs. LEDs give off less heat than incandescent light bulbs and are less fragile than fluorescent lamps. Since an individual device is smaller than a centimetre in length, LED-based light sources used for illumination and outdoor signals are built using clusters of tens of devices.

Incandescent light bulbs for traffic lights and pedestrian crosswalks are gradually being replaced by LED clusters.

Lighting systems using incandescent bulbs are cheap to buy but inefficient, generating from about 16 lumens per watt for a domestic tungsten bulb to 22 lm/W for a halogen bulb. Fluorescent tubes are more efficient, from 50 to 100 lm/W for domestic tubes (average 60lm/W), allowing large energy savings, but are bulky and fragile and require starter circuits. LEDs are robust and moderately efficient, up to 80 lumens per watt (but the average commercial LED outputs 32 lm/W). Thus LEDs are expensive, although their cost is falling. The technologies for LED production are developing rapidly.

Because they are monochromatic, LED lights have great power advantages over white lights where a specific color is required. Unlike the white lights, the LED does not need a filter that absorbs most of the emitted white light. Colored fluorescent lights are made, but they are not widely available. LED lights are inherently colored, and are available in a wide range of colors. One of the most recently introduced colors is the emerald green (bluish green, about 500 nm) that meets the legal requirements for traffic signals and navigation lights.

The largest LED display in the world is 36 metres high (118 feet), at Times Square, Manhattan.

There are applications that specifically require light that does not contain any blue component. Examples are photographic darkroom safe lights, illumination in laboratories where certain photo-sensitive chemicals are used, and situations where dark adaptation (night vision) must be preserved, such as cockpit and bridge illumination, observatories, etc. Yellow LED lights are a good choice to meet these special requirements because the human eye is more sensitive to yellow light (about 500 lm/watt *emitted*) than that emitted by the other LEDs.

Indoor and outdoor LED panels

There are two types of LED panels: conventional, using discrete LEDs, and Surface Mounted Device (SMD) panels. Most outdoor screens and some indoor screens are built around discrete LEDs, also known as individually mounted LEDs. A cluster of red, green, and blue diodes is driven together to form a full-color pixel, usually square in shape. These pixels are spaced evenly apart and are measured from center to center for absolute pixel resolution.

Most indoor screens on the market are built using SMD technology — a trend that is now extending to the outdoor market. An SMD pixel consists of red, green, and blue diodes mounted on a chipset, which is then mounted on the driver PC board. The individual diodes are smaller than a pin and are set very close together. The difference is that minimum viewing distance is reduced by 25% from the discrete diode screen with the same resolution.

Indoor use generally requires a screen that is based on SMD technology and has a minimum brightness of 600 candela per square metre (unofficially called nits). This will usually be more than sufficient for corporate and retail applications, but under high ambient-brightness conditions, you may need more punch to compete. Fashion and auto shows are two examples of high-brightness stage lighting that may require a higher LED brightness. Conversely, when your screen may be in a shot on a television show, the requirement will often be for lower brightness levels with lower color temperatures (common displays have a white point of 6500-9000K, which is much bluer than the common lighting on a television production set).

For outdoor use, you need at least 2,000 nits for most situations, whereas higher brightness types of up to 5,000 nits cope even better with direct sunlight on the screen. Until recently, only discrete diode screens could achieve that brightness level. (The brightness of LED panels also can be turned down.)

For specific projects, you need to take into account factors such as sight lines, local authority planning requirements (if the installation is to become semi-permanent), vehicular access (trucks carrying the screen, truck-mounted screens, or cranes), cable runs for power and video

(accounting for both distance and health and safety requirements), power, suitability of the ground for the location of the screen (check to make sure there are no pipes, shallow drains, caves, or tunnels that may not be able to support heavy loads), and overhead obstructions.

See also

- Laser diode, a coherent solid-state light source
- Nixie tube

External links

- LEDmonthly.com --Updated Everyday - from ledmonthly.com
- How LEDs work - from Howstuffworks.com
- The LED FAQ Pages - A compilation of questions and answers about light-emitting diodes and infrared emitters
- The LED Museum - Information about old and new LED developments
- Don Klipstein's LED Page - A comprehensive LED information resource
- Why LEDs can be 10 times as efficient as incandescents in some applications but not in general home lighting?
- Chart showing voltage drops of various colors
- SPE method, which results in 80l/w (vs 60l/w for fluorescent lighting)
- Information on developing a standard lifetime measurement for LEDs

Sources of light / lighting (edit me...)

Natural/prehistoric light sources:

Bioluminescence (Fireflies, Foxfire, et cetera) | Celestial objects | Lightning

Combustion-based light sources:

Acetylene/Carbide lamps | Candle | Davy lamps | Fire | Gas lighting | Kerosene lamp | Limelight | Oil lamp | Rushlight

Nuclear/direct chemical light sources:

Betalights | Chemoluminescence/Lightsticks

Electric light sources:

Arc lamp | Incandescent | Fluorescent

High-intensity discharge:

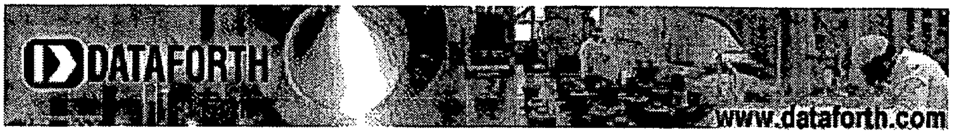
HMI lamps | Mercury-vapor lamps | Metal halide lamps | Sodium vapor lamps | Xenon arc lamps

Other electric:

Electroluminescent (EL) lamps | Inductive lighting | **LEDs** | Neon and argon lamps | Sulfur lamp | Xenon flash lamps | Yablochkov candle

Categories: Display technology | Optical diodes | Lighting | Diodes

---



March 2005

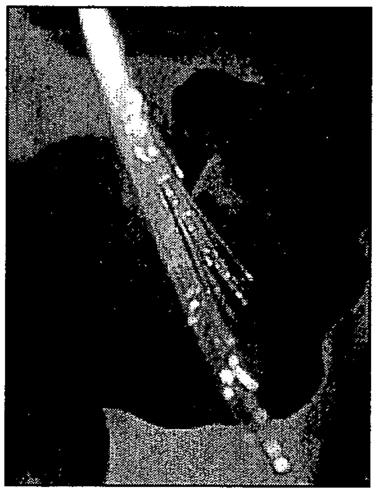
SENSOR TECHNOLOGY AND DESIGN

TOC

A Fluorescent Long-Line Fiber-Optic
Position Sensor

A fluorescent long-line fiber-optic position sensor has been devised for measurement ranges varying from centimeters to many meters where extremely high resolution is not required. The sensor can also measure the position of several objects simultaneously.

Jonathan D. Weiss, Sandia National Laboratories



The device described in this article is intended to satisfy an industrial need for continuous position sensing over a measurement range varying from centimeters to many meters. As a fiber-optic sensor, it has the well-known advantages of immunity to EMI and an inability to create sparks in a potentially explosive environment. Furthermore, it is noncontact. Although a laboratory proof-of-principle has been accomplished, this patent-pending sensor would have to be engineered to satisfy a particular application. Sandia National Laboratories welcomes collaboration with an industrial partner to achieve that end.

Principle of Operation

In its simplest form the sensor (see Figure 1) consists of an optical fiber that is uniformly doped with fluorescers and a small light source that excites or "pumps" the fiber, thereby inducing fluorescence.

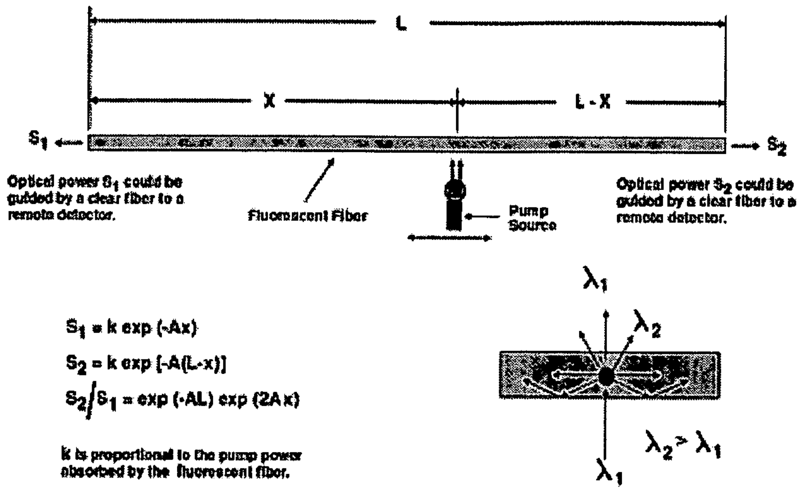


Figure 1. A mobile source of light can create in a doped optical fiber fluorescence radiation that initially travels with equal strength toward both ends from the point of generation. As a result of partial absorption in transit, the signals detected at either end will be different and their ratio, S_1/S_2, yields the location of the source.

It is assumed that the pump emits light in the vicinity of wavelength λ_1 and that the fluorescence spectrum is significant in the vicinity of λ_2, where $\lambda_2 > \lambda_1$. The pump source, which could be the end of another optical fiber, would be attached to a moving object that travels along the fluorescing fiber, although the fiber could also be in motion. It is the relative position between the pump source and the fiber that this sensor detects. How it does so is suggested by the lower right-hand corner of the figure, in which pump light impinges on a fluorescer within the fiber. Some of this optical power passes through the fiber without interaction, while some is absorbed by the fluorescer and is reemitted at the longer wavelength. A fraction of this radiation near λ_2 travels at too large an angle to the axis of the fiber to be guided by it, but the rest of the radiation is guided to either end. Were it not for absorption within the fiber the optical power emerging at the two ends would be equal because of the symmetry of fluorescence emission, regardless of the position x of the pump source. However, absorption naturally exists or can be designed into the fiber, thereby producing the desired position sensitivity. Thus, fluorescence followed by absorption is at the heart of this sensor. High absorption implies high spatial resolution and small range; low absorption implies low spatial resolution and high range.

The basic equations governing the position sensitivity are shown in the lower left-hand corner of Figure 1, where a single extinction coefficient is assumed to be characteristic of the emission spectrum. We note that the logarithm of the ratio of the two signals S_1 and S_2 is linear in x and independent of the strength of the pump source. Thus, variations in source strength have no effect on sensor accuracy. In addition, variations in separation between the pump source and the fluorescent fiber have no effect on the ratio if the pump light is collimated, or (as can be shown) if it produces a distribution of

power along the fiber that is symmetric at any separation. This latter limitation is minor, since most common optical sources produce symmetric distributions of power.

Although insensitivity to pump strength or coupling of pump light to the fluorescent fiber is a distinct advantage of this sensor, signal-to-noise problems will arise if the individual signals S_1 and S_2 are too low. Consequently, to bolster signal strength one would design the sensor to produce as many passes of pump light through the fiber as possible with, for example, a reflector. An optimally shaped bundle of fluorescent fibers whose individual signals are added will also increase signal strength.

It may be possible to produce a similar sensor without fluorescent fibers, but with so-called "side-emitting" fiber bundles that are manufactured for illumination. The clear fibers that make up the bundle are woven together to form a kind of rope. As a result, the individual fibers contain numerous bends that cause light to be scattered out of their core and into space. If the fibers are side-emitting, one would expect them to be "side-receiving." That is, light impinging on them from the side should be scattered into their core and transmitted to either end of the bundle, in contrast to the case with straight, clear fibers. Position sensitivity is achieved because some of this "in-scattered" light will be "out-scattered" before it reaches either end, in a manner analogous to absorption in the fluorescent fiber. The potential advantage of using these bundles is that the wavelength of the source is largely irrelevant. They may, however, be cumbersome for certain applications and perhaps expensive as well. We have not experimented with them.

Laboratory Proof-of-Principle

Description of the Experiment. Figure 2 is a schematic of a laboratory test of this position sensor using off-the-shelf plastic fluorescent fibers from Saint Gobain.

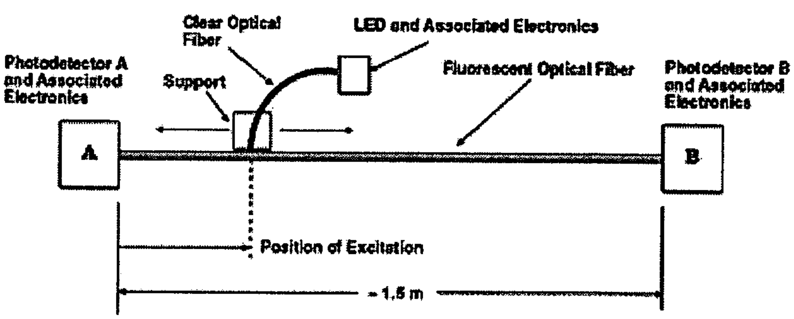


Figure 2. A laboratory test of the long-line fiber-optic position sensor has been conducted. The mobile light source is the end of an optical fiber that is illuminated by an LED.

Their diameter was 1 mm. The pump source was a blue LED from Nichia that emitted in the neighborhood of 470 nm (or, in one case, a green LED emitting around 520 nm) that was coupled to the fluorescent fiber through a clear fiber. This fiber was attached to a

support that was manually positioned at various places along the fluorescent fiber, which, in turn, was placed on an aluminum reflecting surface to produce an additional pass of pump light through it. At each end was a photodetector consisting of a back-biased PIN diode and a series resistor, whose voltage was proportional to the optical power falling on the PIN diode. In one set of experiments, the pump light was steady and the fluorescent fiber was covered, except at the point of excitation, to shield it from ambient lighting. In another, the entire fiber was exposed to ambient lighting, but the pump light was modulated at ~11 kHz. The electrical output of either detector was filtered at that frequency, which was far removed from the frequencies of any ambient lighting. Modulation and filtering is the obvious way to overcome any influence of background lighting. The technique also provides a means of monitoring the position of several objects simultaneously using a single fluorescent fiber (or bundle) and a single pair of detectors: The pump light from each object would be modulated at a different frequency, and the multifrequency electrical signal emerging from either detector would be filtered at these frequencies. Mechanical interference among the objects would obviously have to be avoided.

Presentation of Data. Figure 3 shows the positional response of an amber fluorescent fiber to steady pumping from the blue LED.

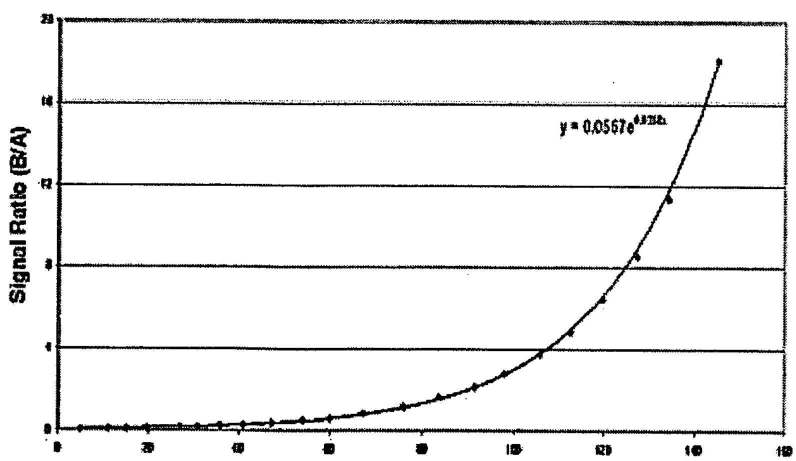


Figure 3. The signal ratio vs. position of the light source for an amber fluorescent fiber that has been excited by steady light from a blue LED exhibits exponential behavior consistent with simple theory. Linear behavior is obtained through its logarithm. This fiber was physically shielded from ambient lighting.

We note the excellent fit of the data to an exponential rise, as indicated by the continuous curve described by the equation. Equating the multiplicative factor, 0.0557 to exp(-AL) in Figure 1, we arrive at an alternative value for 2A of 0.03815, which is close to 0.0398 derived from the fit. Differences in detector gain and coupling of the fiber ends to the two detectors could explain this small discrepancy. Unless these are minimized, the values of **k** in Figure 1 would have to be different, but the basic behavior of the

sensor is unchanged. Despite the scatter in the individual signals shown in Figure 4, their ratio is nearly free of it.

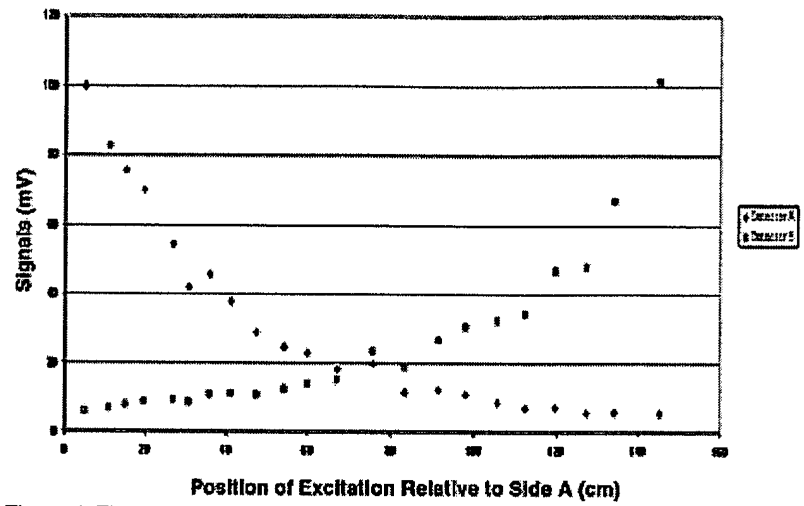


Figure 4. The individual signals from the amber fluorescent fiber contain scatter that the ratio does not. When used ratiometrically, the sensor is therefore insensitive to variations in the strength of the source and its coupling efficiency to the fluorescent fiber.

The scatter arose because the relatively unsophisticated nature of the apparatus in Figure 1 did not allow for reproducible coupling between the pump and sensor fibers, but it does demonstrate the point made earlier.

Figure 5 is the same as Figure 3, except that the modulation and filtering technique was used on an exposed fiber.

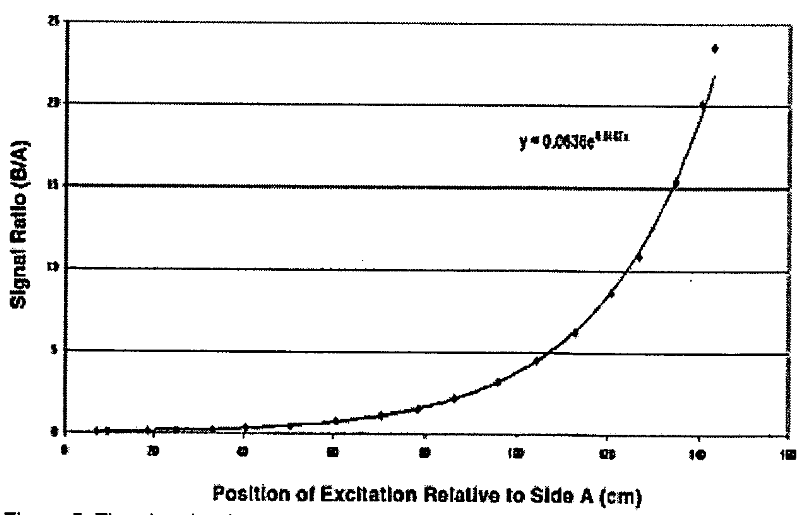


Figure 5. The signal ratio vs. position of the light source for an amber fluorescent fiber that has been excited by modulated light from a blue LED exhibits similar exponential behavior. Modulation allows the effects of ambient lighting to be filtered out without physical shielding.

The results are similar, although the multiplicative factor deviates by ~13% from that in Figure 3. It is probable that the discrepancy in AC characteristics of the two detectors could explain this, since no attempt was made to match (or optimize) them. This fiber was also

pumped steadily with the green LED, although its fluorescence efficiency is noticeably lower when excited by this spectral region than by the blue. Despite the smaller individual signals, the signal ratio in Figure 6 is essentially the same as that in Figure 3.

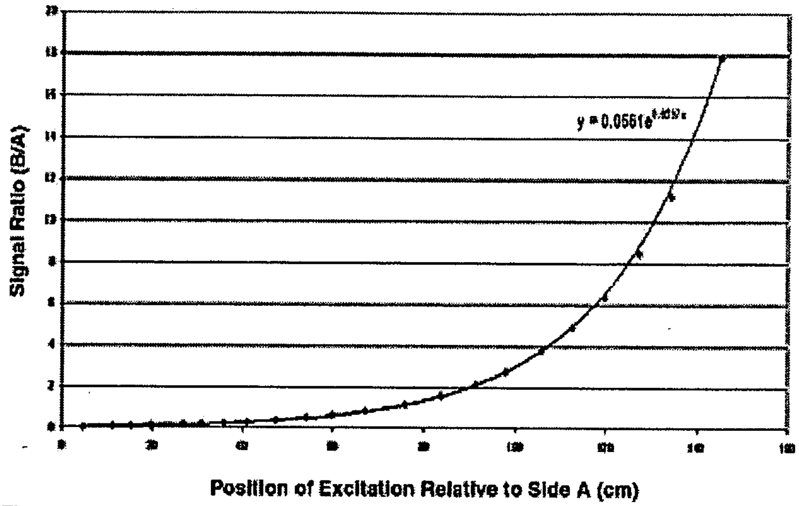


Figure 6. The signal ratio for an amber fluorescent fiber excited by a modulated green LED is also exponential in nature. This behavior suggests that the optical spectrum of the fluorescence radiation is relatively insensitive to the spectrum of the source.

A red fluorescent fiber was also studied using modulated pump light from the blue LED. Figure 7 displays its exponential positional response, though with a different absorption constant from the amber fiber.

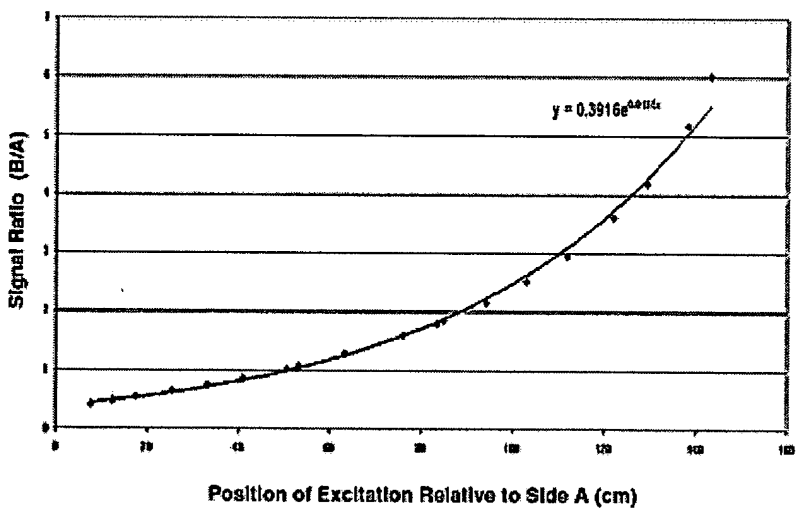


Figure 7. The signal ratio for a red fluorescent fiber using a modulated blue LED is also exponential, as predicted by theory.

Figure 8 shows the scatter in the individual signals, not present in the ratio.

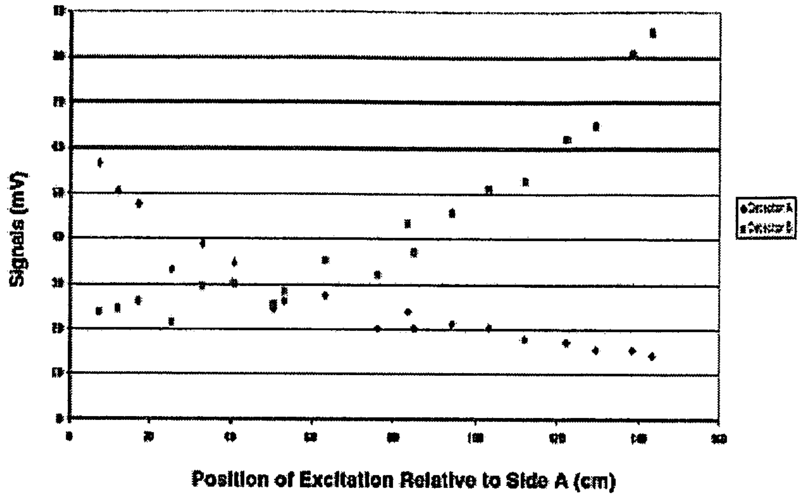


Figure 8. The individual signals from the red fluorescent fiber exhibit scatter that the ratio does not, as in the case of the amber fiber.

Similar measurements were performed on a green fluorescent fiber using modulated light from a blue LED. Its signal ratio was exponential also, but with a much lower absorption coefficient of 0.0071/cm (as opposed to 0.0185/cm and 0.0407/cm).

Summary

We have presented a laboratory proof-of-principle of a fluorescent long-line fiber-optic position sensor, suitable for measurement ranges varying from centimeters to many meters and for which extremely high resolution is not needed. We have also described a method by which the position of several objects can be measured simultaneously. Not discussed are the configurations that can be used to perform measurements, in addition to linear position. These include angle measurements, two dimensional position measurements with arrays of fluorescent fibers, and simultaneous high- and low-resolution measurements by combining fibers with high and low absorption.

Acknowledgment

This article was written by Sandia National Laboratories under Contract No. DE-AC04-94AL85000 with the U.S. Department of Energy. The U.S. government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this manuscript, or allow others to do so, for U.S. government purposes.

Jonathan D. Weiss, Ph.D., is a Senior Member of the Technical Staff, Sandia National Laboratories, Albuquerque, NM; 505-845-8213, jdweiss@sandia.gov.

MORE!

For further reading on this and related topics, see these *Sensors* articles.

"Next-Generation Proximity and Position Sensors," March 2004
"Angular Position Sensing with 2-Axis Hall ICs," March 2003
"A Magnetic Linear Position Transducer for Fail-Safe Target Tracking," November

2002
"An Introduction to Fiber-Optic Sensors," December 2001
"The Next Generation of Position Sensing Technology," Part 1 and Part 2, March and April 2001
"Measuring with Light," Part 1 and Part 2, April and May 2000
"An Intrinsically Safe Position Transmitter," January 2000
"Magnetostrictive Linear Position Sensors," November 1999
"Designing and Building an Eddy Current Position Sensor," September 1998
"The Evolution of Proximity, Displacement, and Position Sensing," April 1998

Send to a friend Submit comments Printer friendly version